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EVALUATING A MOUNTAIN PINE BEETLE INFESTATION WITH THE AID OF 35 MM COLOR AERIAL PHOTOGRAPHY

Report No. 3

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INTRODUCTION

This is the third in a series of reports describing the methods and results of a 35 mm aerial photographic survey designed to measure the trend of a mountain pine beetle infestation in high elevation lodgepole pine stands. Previous survey results were reported in 1972 and 1973 (Klein, 1972, 1973). Plans are to continue the survey annually until the infestation subsides to a very low level.

This report will attempt to emphasize only those phases that are unique to this survey; however, it will be necessary, on occasion, to reiterate certain past procedures to provide continuity and inform those who have access to only this report and none of the previous ones.

The procedures and findings in this report are based on past studies and operational 35 mm aerial photographic surveys which have shown that lodgepole pine trees killed by the mountain pine beetle can be accurately detected and counted. In the Moose Creek infestation, within boundaries of the survey area (Figure 1), the number of trees killed during 1971 and 1972 was 0.66 and 2.74 trees per acre, respectively. The 1974 survey of the 1973 infestation, showed a slight increase to 3.14 trees per acre.

PURPOSE

The purpose of these aerial photographic surveys is to record the year-by-year depletion of lodgepole pine stands by the mountain pine beetle using the most efficient and least expensive system available. Additionally, by knowing the past rate and sequence of tree killing and comparing it to data gathered from trend studies (Parker, 1973), it is possible to estimate immediate future losses within reasonable bounds.

AREA

The photo reconnaissance area, approximately 25,000 acres in size, is on the Moose Creek Plateau on the Targhee National Forest, Idaho. Most of the area, ranging in elevation from 7,000 to

slightly more than 8,000 feet, has been extensively logged as a reaction to the resurgent and advancing infestation to the south and west. (Figure 2). This infestation, part of a much larger one, was momentarily checked by an intensive control program that was finally terminated in 1971. To the immediate east in Yellowstone National Park, where control was not undertaken, the infestation made its sweep and is now on the decline.

A comparison of the area covered during the 1974 survey with that of the two previous years, is shown in Figure 1 in the appendix.

METHODS

Specific details concerning the 1974 aerial photographic survey follows:

Time:	27 August, between 11:15 a.m. and 1:15 p.m. (MDT)
Aircraft:	Cessna 337B STOL
Average Flying Height:	3,000 feet
Scale:	1:3,300
Camera:	Nikon F (F 5.6 @ 1/500)
Lens:	Auto-Nikkor 85mm w/Nikkor LIA Filter
Calculated Ground Speed:	80 MPH
Film:	Kodacolor II - 3 R Enlargements
Plot Size:	Calculated - 4 acres; Actual - 4.84 acres
Total Number of Plots:	43

Five parallel flight lines, approximately one mile apart, were flown in a north-south direction at mean elevation. Stereo triplets were taken at approximately one-mile intervals along each flight line. However, this interval varied slightly to avoid the many clearcut areas. Cycle interval between exposures for 60-70 percent overlap was approximately four seconds. Other than a strong but consistent westerly crosswind and variable turbulence, the weather was good and relatively cloud free. The platform mounted camera was kept level by use of a small fisheye bubble mounted on its back plate.

A double sampling system was used. Seven (16 percent) of the 43 plots were ground checked to provide a correlation between photo counts and ground truth. Factors used in the selection of check plots were level of infestation, (more than two faders[1]) accessibility, and representativeness of the area. All photo plots were first located on resource photography and then transferred to a field map.

The ground truth survey was undertaken by a two-man crew during the period 7-11 October. Plot corners and boundaries were marked with plastic flagging and string; the plot was then divided into 1-1½ chainwide lanes for ease of orientation and examination. All recent mountain pine beetle-killed trees were then located, examined and classified as to (1) a 1973 attack or fader (Figure 3) or (2) a new (1974) attack. All 1973 attacks (faders) were mapped and located on the 35 mm photos (Figure 3). Photo scale was checked by measuring one side of each plot with a topographic tape and clinometer.

RESULTS AND OBSERVATIONS

There was an excellent correlation (r=0.98) between photo and ground counts (Figure 4). The adjustment of the total photo sample by linear regression is computed as follows:

1. Mean tree count on all 43 photo plots:
   $\bar{x}_1$ = 13.19 trees per plot

2. Mean tree count on seven plot photo subsample:
   $\bar{x}_2$ = 22.0

3. Mean tree count on seven plot field subsample:
   $\bar{y}_2$ = 24.29 trees per plot

4. Mean plot size:
   calculated = 4.00 acres
   adjusted = 4.84 acres

5. Regression equation:
   $Y = a + bX = 1.45 + 1.03X$

6. Adjusted mean tree count:
   $\text{yrd.} = \bar{y}_2 + b(\bar{x}_1 - \bar{x}_2) = 15.21$ trees per plot

7. 1973 attack level (corrected for scale):
   3.14 trees per acre

1/A fader is a mountain pine beetle - attacked tree whose crown discolors the season (1974) following attack (1973).

On-the-ground measurements of the seven plot boundaries showed an overall decrease in scale. Plot size ranged from 4.44 to 5.42 acres and averaged 4.84 acres, a 21 percent increase over the calculated area.

Tree killing on the Moose Creek Plateau has increased steadily over the past three years - 0.66 trees per acre in 1971, 2.74 trees per acre in 1972, and 3.14 trees per acre in 1973. The 1973 level exceeds last year's "ball park" estimate of 2.23 trees per acre made from nine ground truth plots (Klein, 1974). This year, a total of 142 newly attacked trees were found on the seven ground truth plots, resulting in an estimated 1974 attack level of 4.19 trees per acre - a slight increase over 1973. The validity of this estimate, however, is questionable, but can be verified in 1975. A summary of the four-year trend of mountain pine beetle induced mortality on the Moose Creek Plateau follows:

Year	No. Dead Trees Per Acre			METHOD
	Predicted	Actual	Ave. DBH 1/	
1971	-	0.66	12.5	49 photo plots
1972	-	2.74	14.7	44 photo plots
1973	2.23 2/	3.14	12.1	43 photo plots
1974	4.18	-	12.7	7 ground plots
TOTAL		6.54		

This trend as compared to the trend of lodgepole pine mortality during a seven-year outbreak period in Yellowstone National Park (Parker, 1973) is shown in Figure 5 in the appendix.

Results of the cursory ground examination showed a significant reduction in size of trees attacked from 14.7 d.b.h. in 1972 to under 13-inches d.b.h. in 1973 and 1974.

Within the survey area, heaviest tree losses were in the southwest corner with least mortality occurring in the northeast portion.

1/Determined on ground truth plots
2/Nine ground truth plots.

CONCLUSIONS

It is apparent that tree losses on the Moose Creek Plateau will never attain the damaging proportions experienced in other areas of the Targhee National Forest and elsewhere. A comparison with the trend and losses incurred in the southeast corner of Yellowstone National Park may serve as one example. It is assumed, however, that the peak of tree killing on Moose Creek Plateau was attained in 1973 (3.14 trees per acre) or at the very worst, was reached in 1974 (4.18 trees per acre). In the Yellowstone infestation at the height of the outbreak, accumulated losses of trees 5-inches d.b.h. and greater amounted to 50 trees per acre. In the Moose Creek Plateau infestation, assuming a 1974 maximum tree loss of 4.2 trees per acre, total mortality to date is less than eleven trees per acre. Irrespective of whether peak mortality was reached in 1973 or 1974, tree killing should begin to decline in 1975. Some possible reasons for this relatively low level of tree killing and downward trend follows:

1. Studies have shown that lodgepole pine losses by the mountain pine beetle decreases with elevation (Amman, et al, 1973; Stipe, 1973).

2. Accelerated timber cutting (Figure 2) has significantly reduced the amount of available food to the encroaching beetle populations. Cutting priority has been in the larger, high-value stands. This was evident from the reduction in diameter of the newly infested trees.

3. The original and residual stand structure was and is not conducive to abundant mountain pine beetle populations. Essentially a function of climate and elevation, large diameter trees are less abundant, slower growing, shorter than similar aged trees at the low elevations, and therefore incapable of producing abundant beetle populations. With the removal of many of the large diameter trees, infestation intensity is reduced and future losses, although imminent, should be considerable less than if no cutting was done.

A fourth 35 mm photographic reconnaissance survey will be done during the summer of 1975 to continue documentation of the trend of this mountain pine beetle outbreak and to check current predictions.

REFERENCES

Amman, Gene D., Bruce H. Baker, and Lawrence E. Stipe. 1973. Lodgepole pine losses to mountain pine beetle related to elevation. USDA Forest Service Res. Note. INT-171, 7p.

Klein, William H. 1973. Evaluating a mountin pine beetle infestation with the aid of 35mm aerial photography USDA Forest Service, Region 4. Div. Timber Management, Ogden, Utah, 7p., illus.

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Parker, Douglas L. 1973. Trend of a mountin pine beetle outbreak. J. Forestry 71(11):668-670.

Stipe, Lawrence E. 1973. Mountain pine beetle trend and impact study near Spring Creek Park, Bridger National Forest. USDA Forest Service., Region 4, Div. Timber Management, Ogden, Utah, 2p.

Appendix

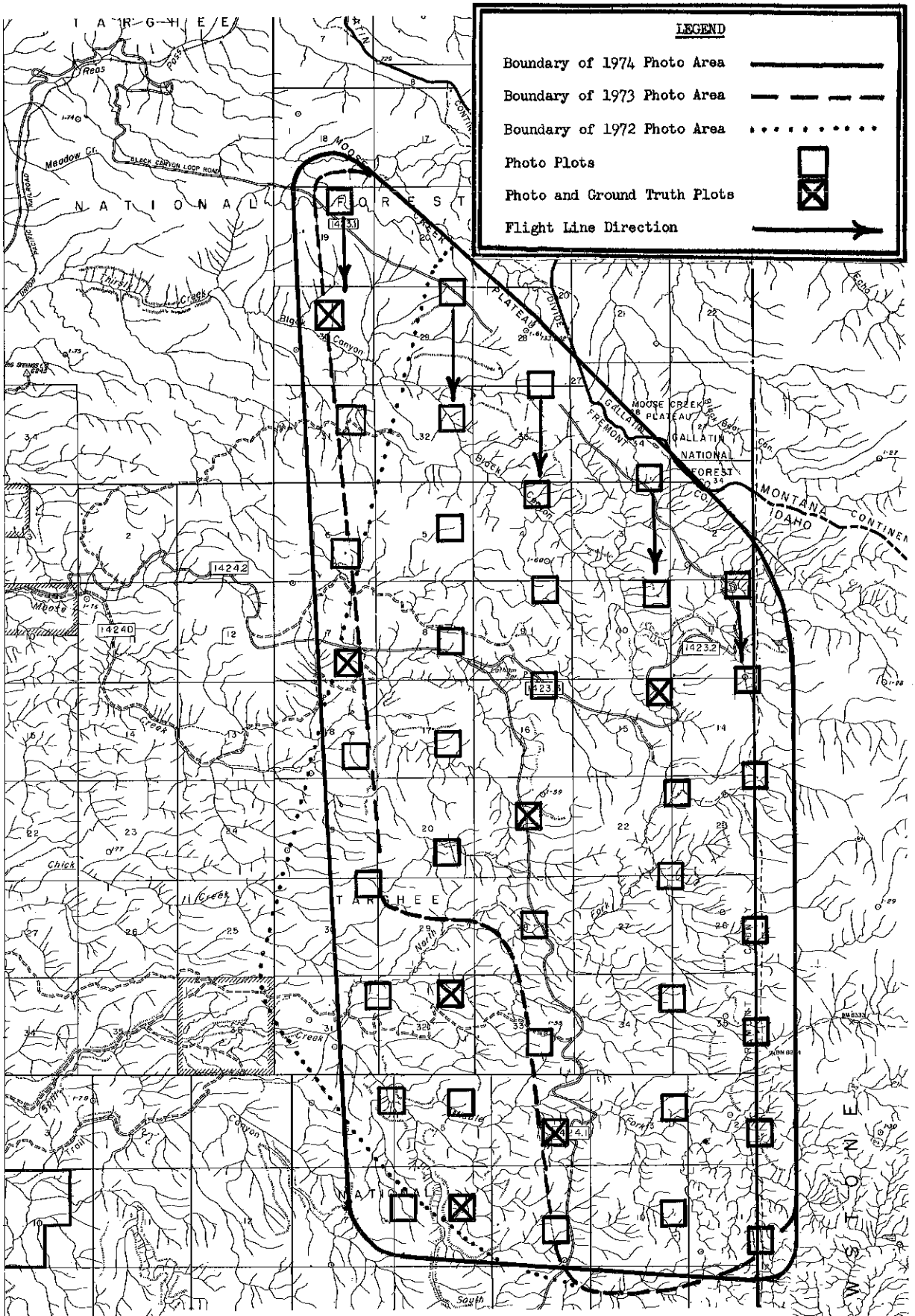

Figure 1. Moose Creek Plateau and adjacent area showing the areas covered by the 1972, 1973, and 1974 35mm photographic surveys.

Figure 2. Moose Creek Plateau showing extensive harvest operation. Yellowstone National Park is in upper right.

Figure 3. Top: Vertical stereogram of plot 5-48. Bottom: 1973 mountain pine beetle-killed lodgepole pine (faders) shown by arrow in top photo.

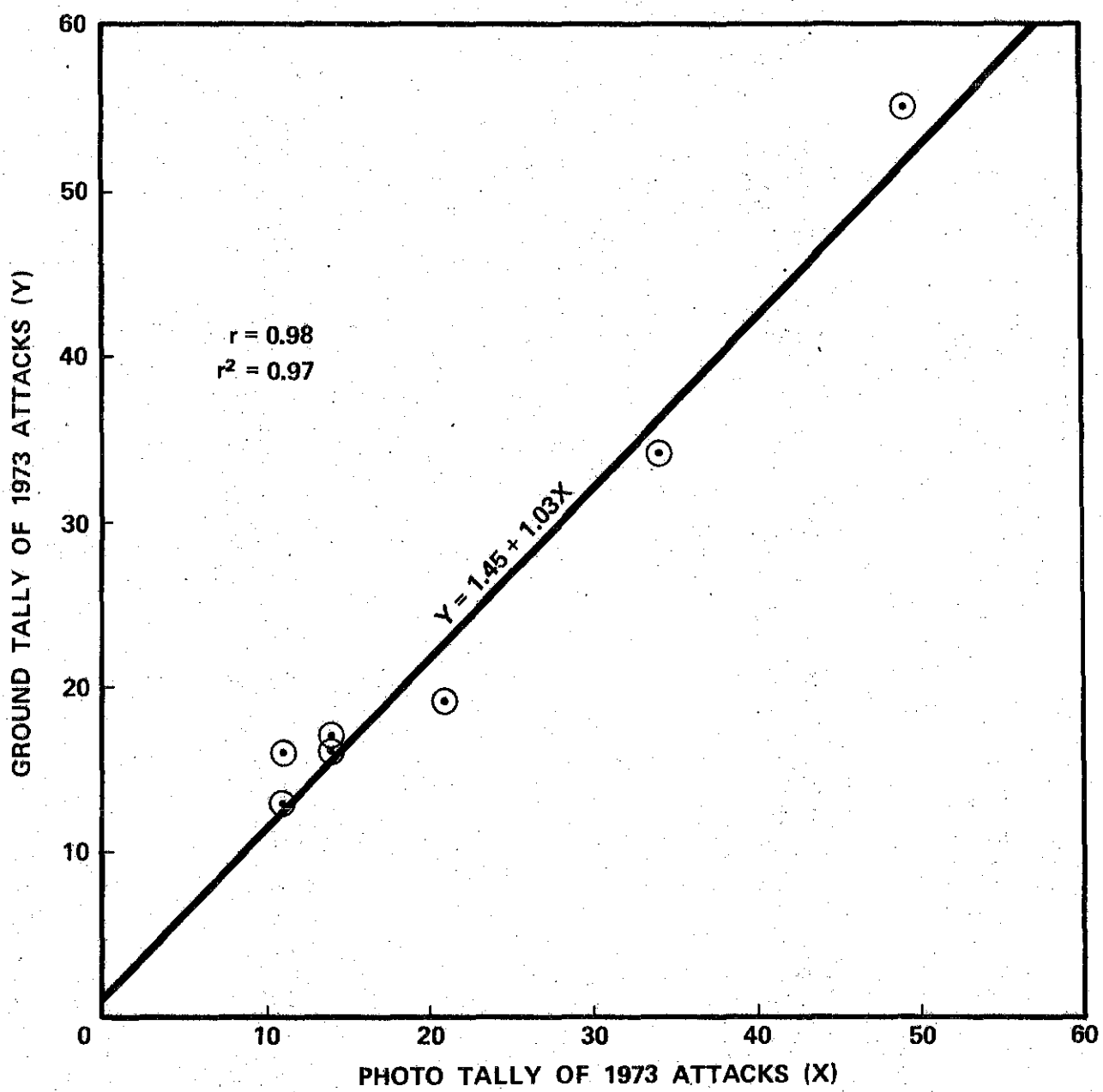

FIGURE 4. Comparison of Photo-to-ground Counts of Logepole Pine Killed by the Mountain Pine Beetle - Moose Creek Plateau, Targhee National Forest.

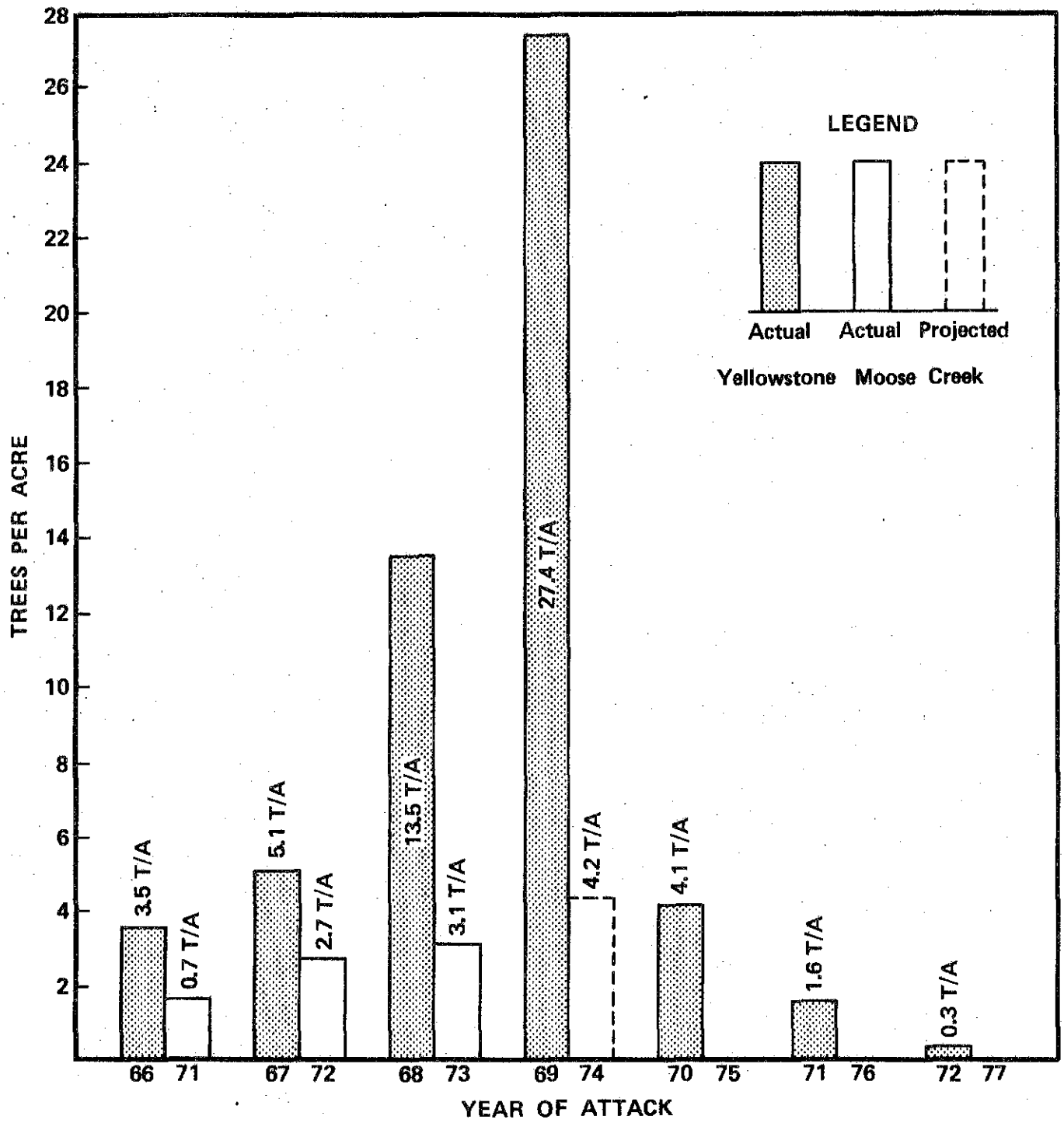

FIGURE 5. Comparison of the Annual Rate of Mountain Pine Beetle Caused Tree Mortality Between Yellowstone National Park and Moose Creek Plateau.